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13. ABSTRACT *(Maximum 200 Words)*

As part of the Global Emission Inventory Activity (GEIA) of the International Global Atmospheric Chemistry (IGAC) Project, we have conducted a survey of the spatial and temporal distribution of biomass burning in India and Southeast Asia during 1987. This survey was conducted using nighttime images from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) available in analog (film) format at the National Snow and Ice Data Center at the University of Colorado.

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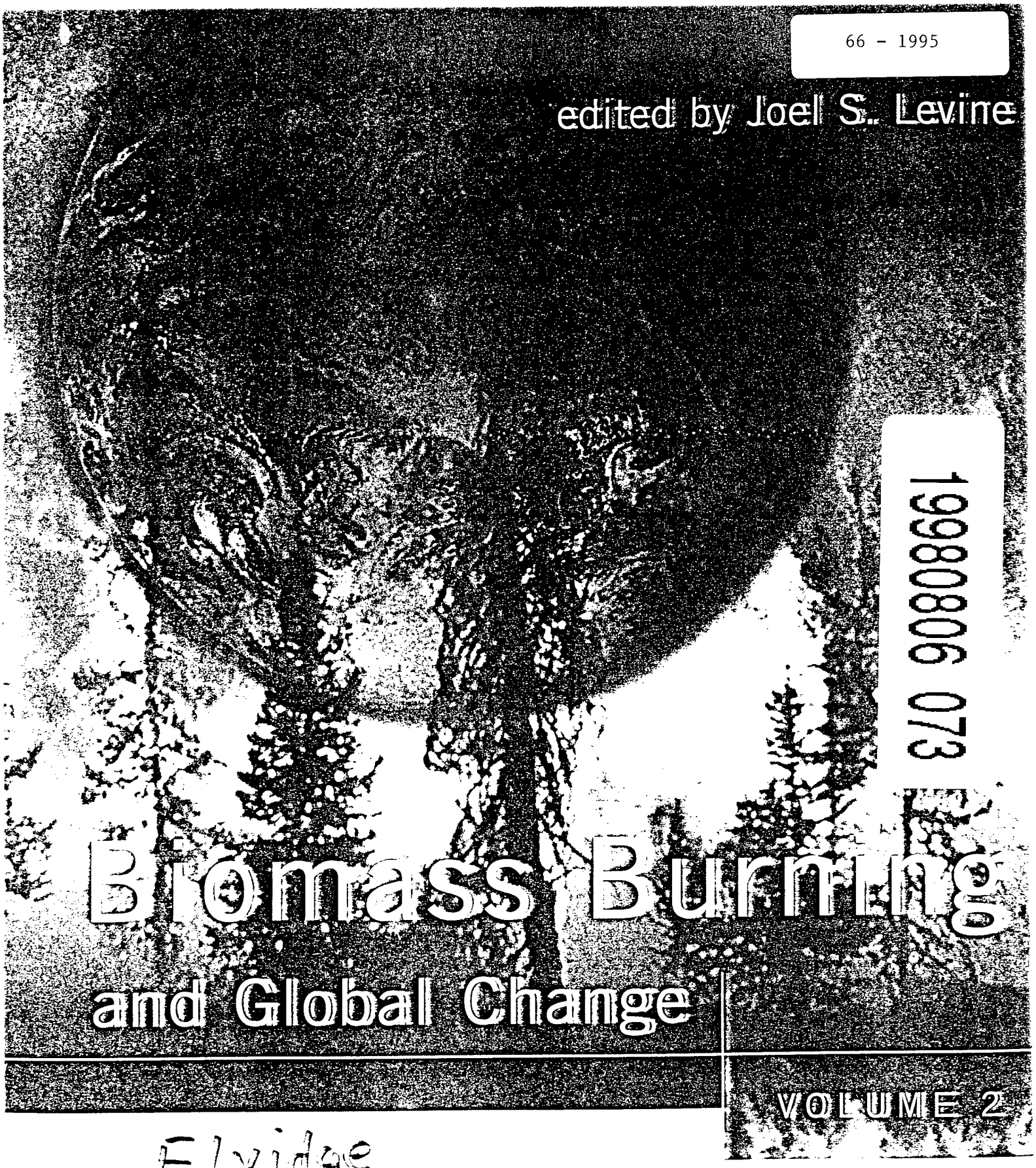

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Biomass Burning and Global Change

VOLUME 2

Elvidge

Biomass Burning in South America, Southeast Asia, and Temperate and Boreal Ecosystems, and the Oil Fires of Kuwait

Biomass Burning in Southeast Asia

Survey of Fires in Southeast Asia and India During 1987

Christopher D. Elvidge and Kimberly E. Baugh

As part of the Global Emission Inventory Activity (GEIA) of the International Global Atmospheric Chemistry (IGAC) Project, we have conducted a survey of the spatial and temporal distribution of biomass burning in India and Southeast Asia during 1987. This survey was conducted using nighttime images from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) available in analog (film) format at the National Snow and Ice Data Center at the University of Colorado.

The Operational Linescan System (OLS) is an oscillating scan radiometer designed for cloud imaging with two spectral bands (VIS and TIR) and a swath of 3600 km with a nominal spatial resolution of 2.7 km. The "VIS" bandpass straddles the visible and near-infrared (VNIR) portion of the spectrum with a full-width-half-maximum (FWHM) of 0.58–0.91 μm. The TIR band has a FWHM of 10.3–12.9 μm. At night the VIS band signal is intensified using a photomultiplier tube (PMT). The purpose of this light intensification is the detection of clouds at night using the VIS band data.

One of the consequences of this light intensification is that faint visible and near-infrared emission sources, such as city lights and fires, can be detected. The nighttime fire detection capabilities of the DMSP-OLS was first noted by Croft (1973), who described the observation fires in Africa using film products. The first systematic inventory of fires with analog OLS data was accomplished by Cahoon et al. (1992), who manually digitized fire points from film produced from nighttime OLS orbits over Africa.

The DMSP program began in 1972 and, except for minor interruptions, has had at least one day–night satellite acquiring OLS data up to the present. Because of the large data volume and restrictions on access to the data, a digital archive for DMSP-OLS data was not established until 1992. A film archive established in 1974 at the NOAA National Geophysical Data Center holds analog data from approximately 1.7 million OLS orbits acquired in the 20 years before 1992. The visible band was printed on the film as a positive, making VNIR emission sources clear and backgrounds black. The thermal band was printed as a negative, making cold objects such as clouds and ice clear, and most of the land and water surfaces black.

Methods and Results

This study was initiated by conducting a visual review of the analog OLS films for 1987. A total of 37 nighttime images covering India and Southeast Asia were found (table 63.1). In the nighttime visible data it was possible to observe city lights, gas flares, and fires. The thermal band film products were used where available

Table 63.1 Nighttime OLS images

India	Insular Southeast Asia	Peninsular Southeast Asia
	January 2	January 2
		January 18
January 20	January 20*	
February 3		February 3
	February 5*	
		February 9
		February 18
	February 24*	
	March 10*	
March 24*	March 24*	
March 24*		
March 25*		
March 25*		
April 28	April 28	April 28
April 30		
		June 21
June 26	June 26	
		July 1
		July 26
July 27		
		August 18
August 22		
		August 23
		September 22
September 24		
September 25		
October 14		October 14

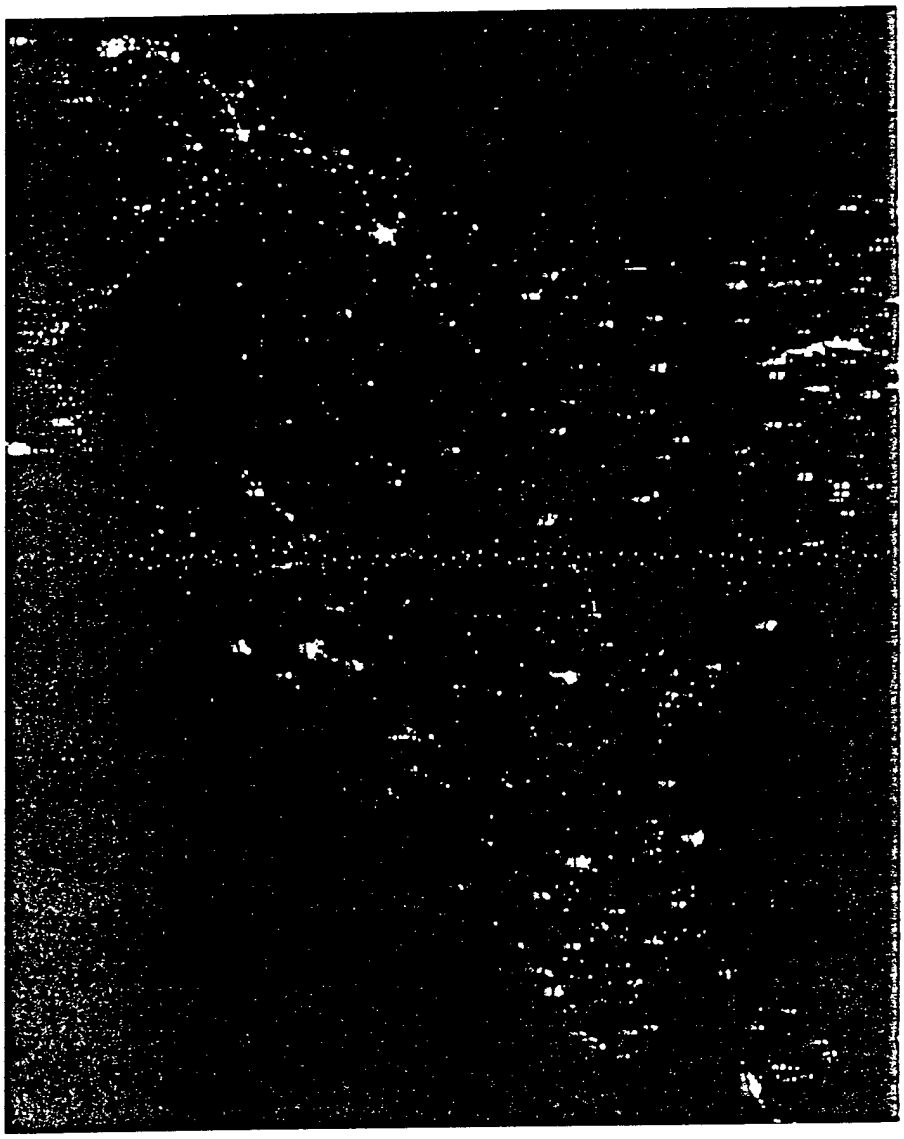

Figure 63.1 Analog DMSP-OLS image of India from 3 February 1987, a night without detectable biomass burning

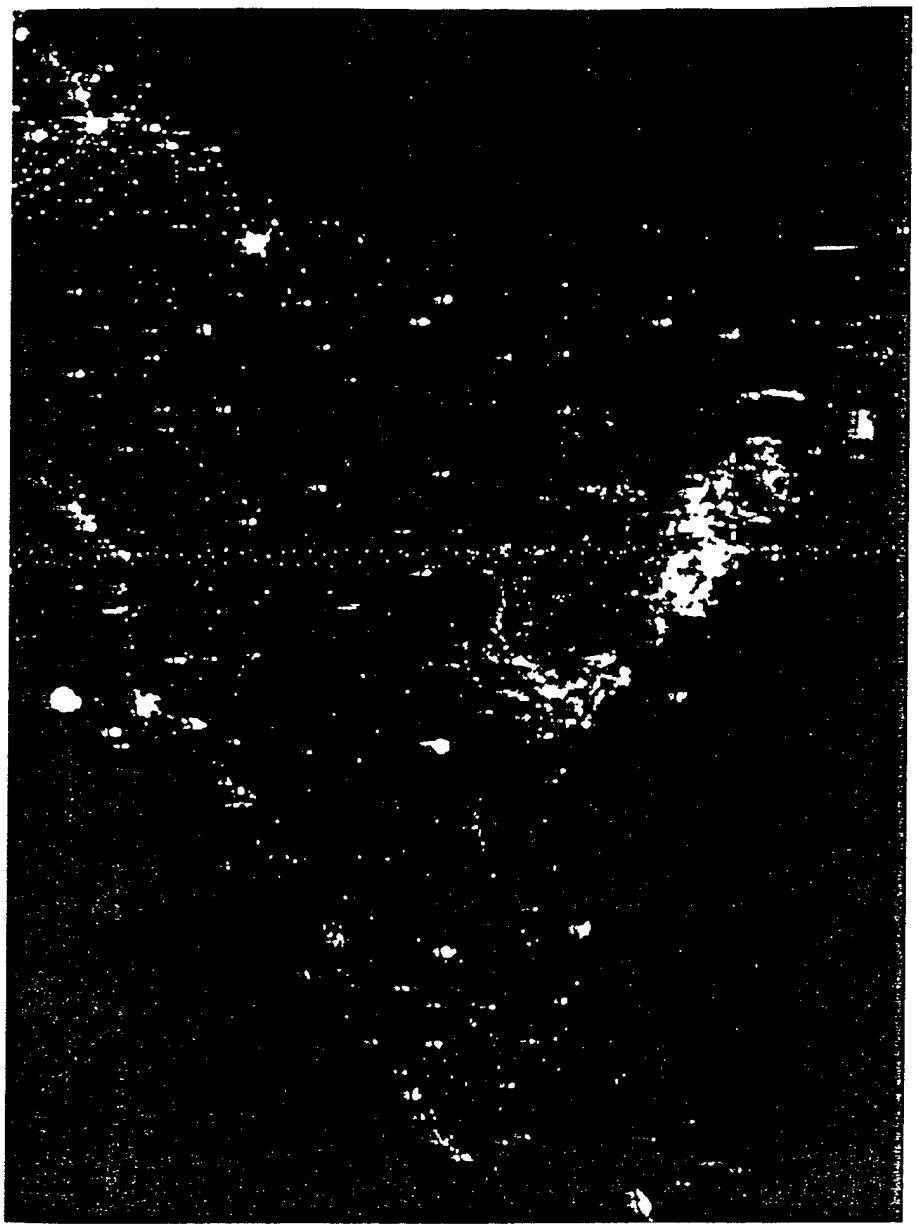

Figure 63.2 Analog DMSP-OLS image of India from 25 March 1987, a night with biomass burning

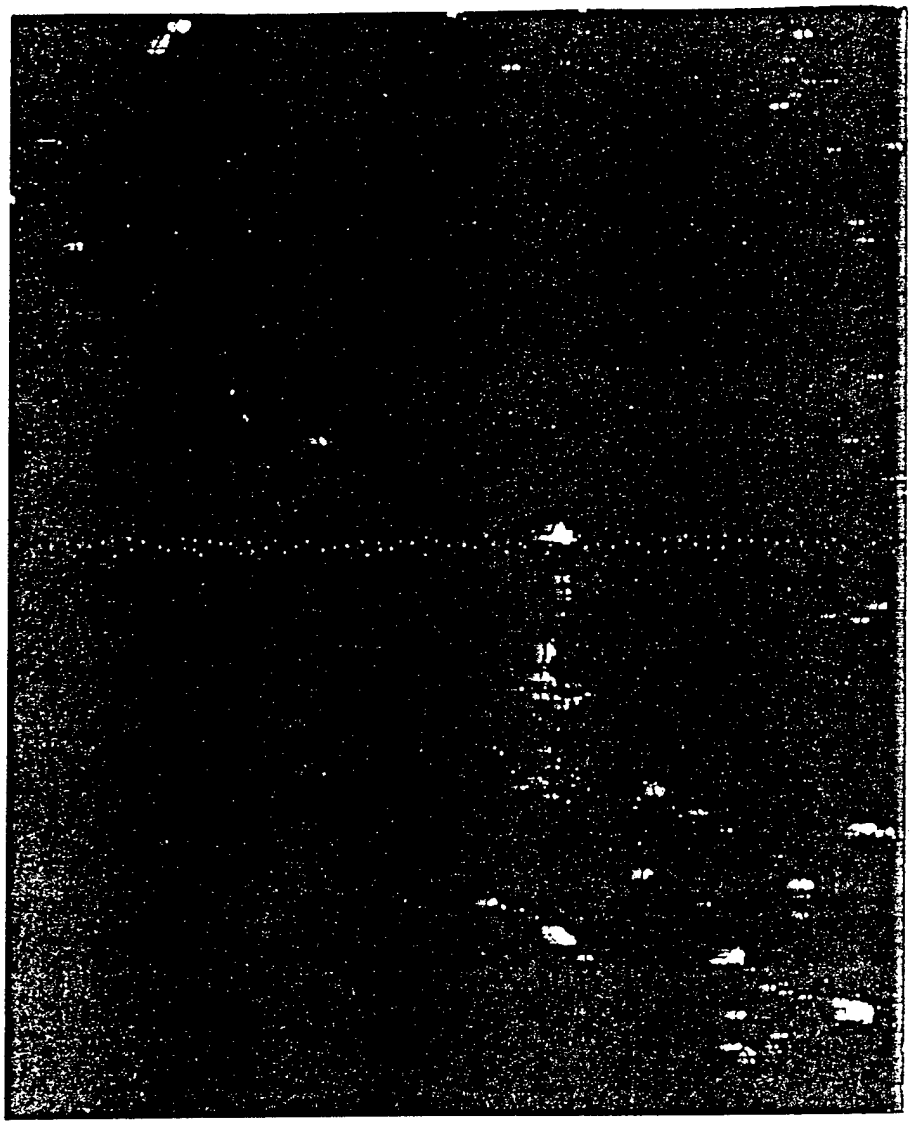

Figure 63.3 Analog DMSP-OLS image of S.E. Asia from 28 April 1987, a night without detectable biomass burning

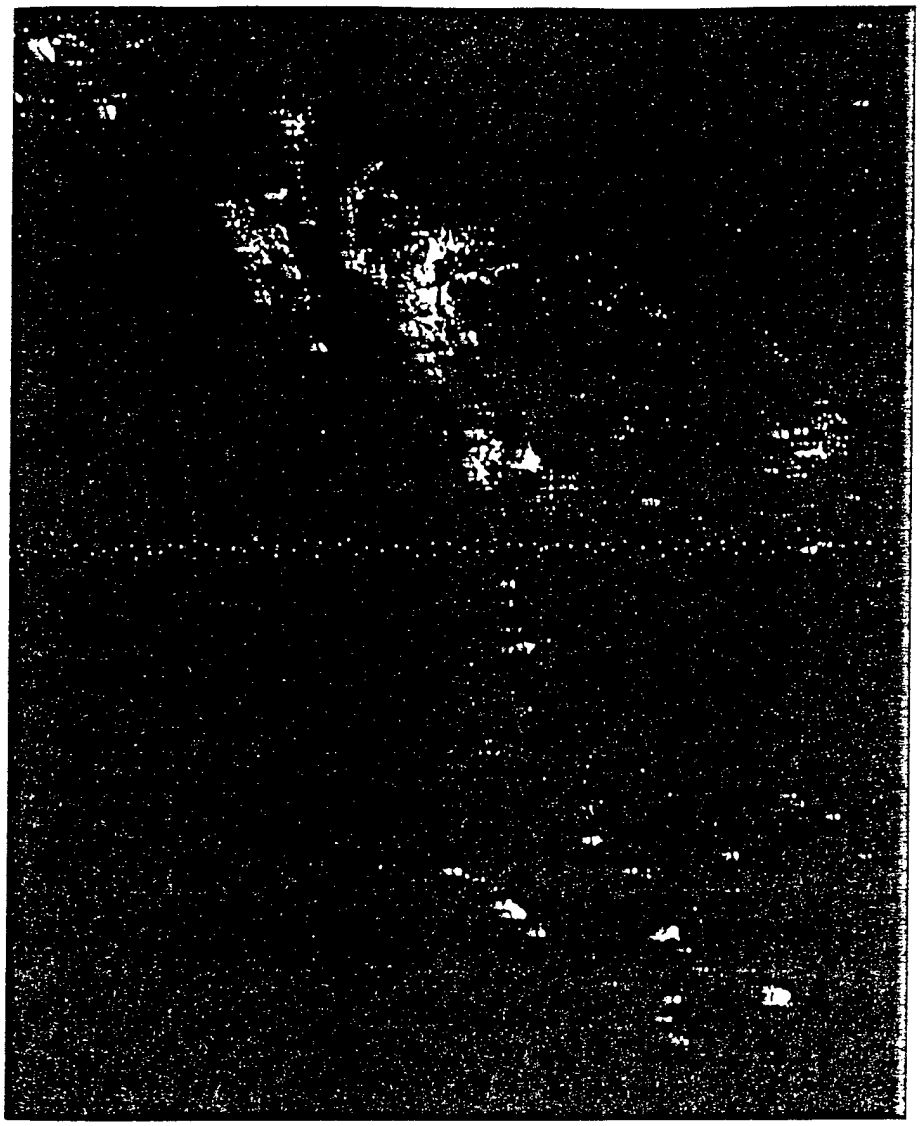

Figure 63.4 Analog DMSP-OLS image of S.E. Asia from 24 February 1987, a night with biomass burning

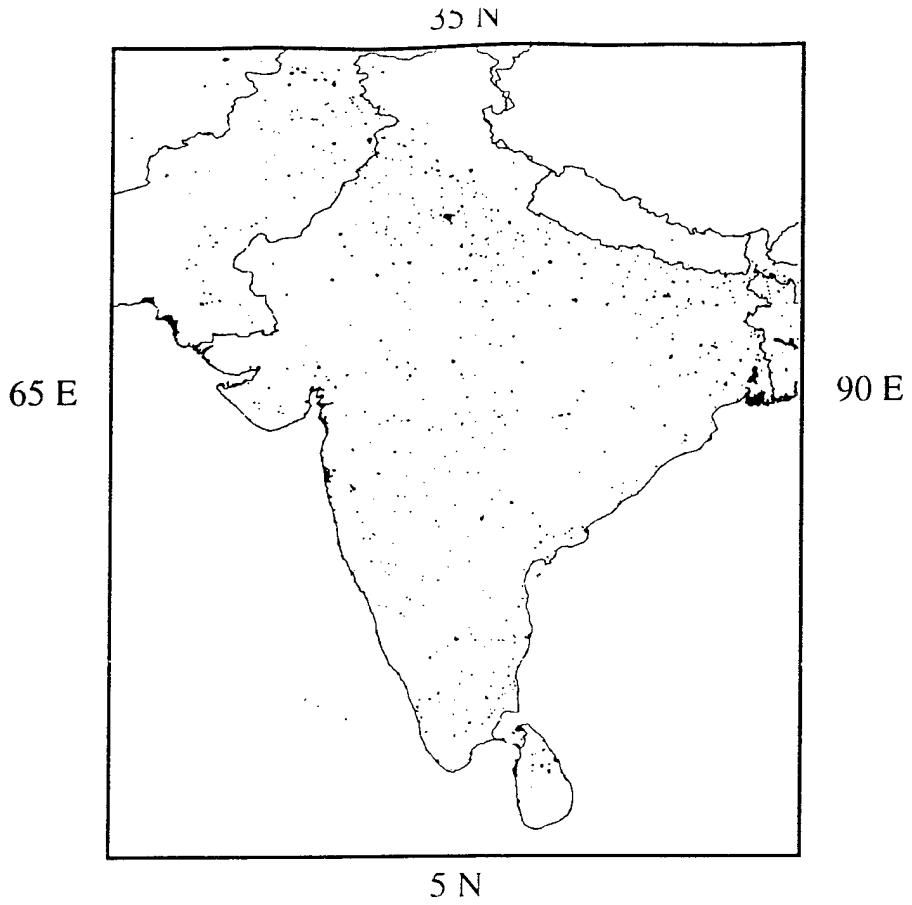

Figure 63.5 Digital chart of the world (DCW) outlines of the India region showing populated place lines (cities) used for the geolocation of the 1987 DMSP-OLS data

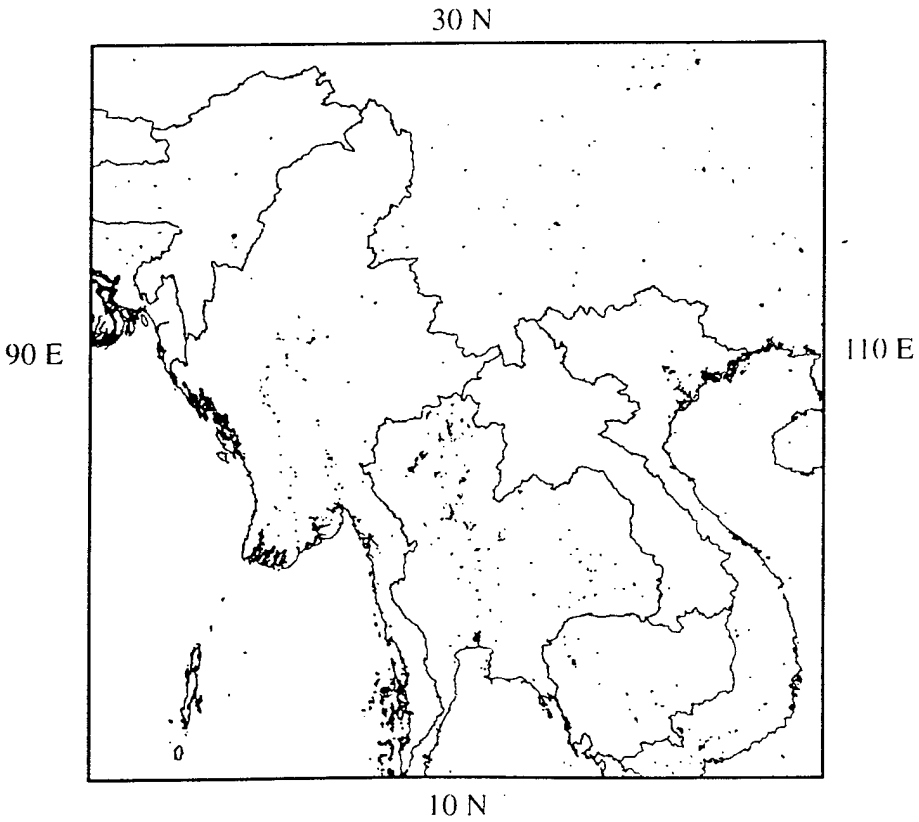

Figure 63.6 Digital chart of the world outlines of Southeast Asia showing populated place lines used in the geolocation of the 1987 DMSP-OLS data

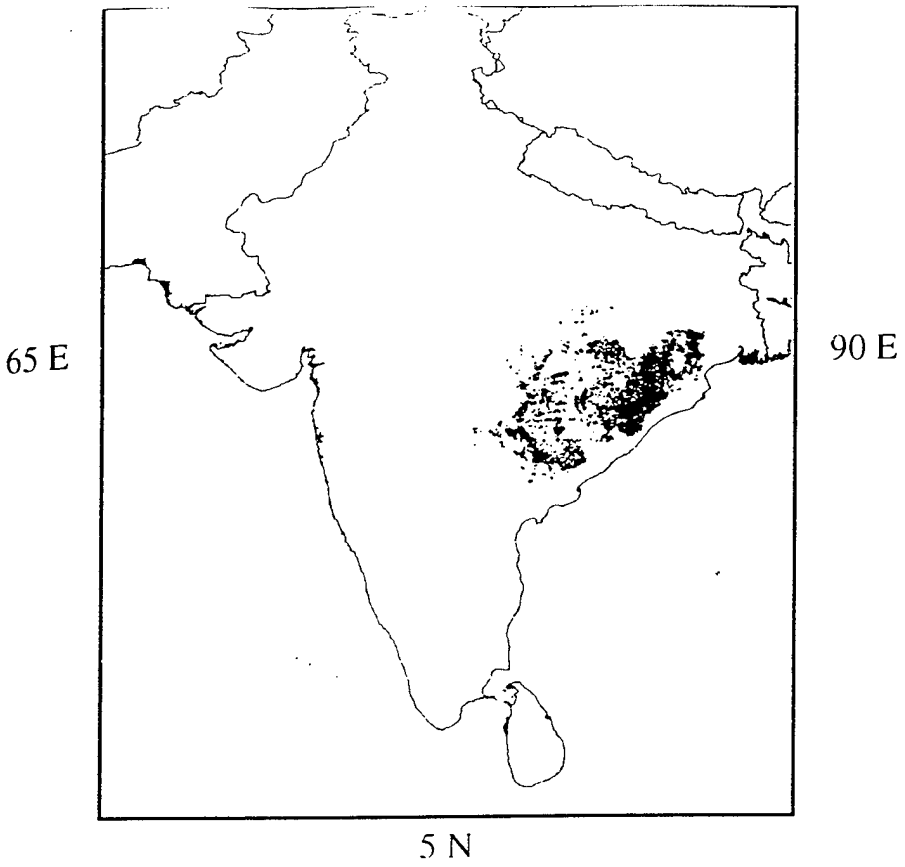

Figure 63.7 Cumulative extent of biomass burning in India during 1987 derived from analog DMSP-OLS images

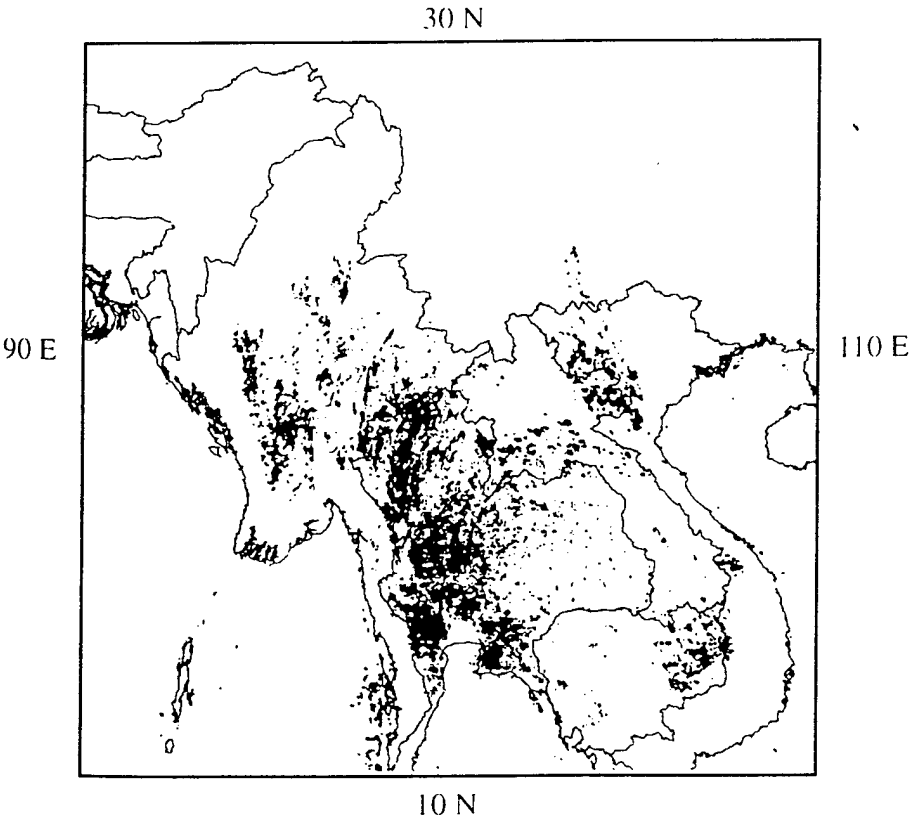

Figure 63.8 Cumulative extent of biomass burning in Southeast Asia during 1987 derived from analog DMSP-OLS images

to examine the extent of cloud cover at the time of the visible band data acquisition. The thermal band films were not useful in locating fires because the data were printed as a negatives. Hot spots are thus black on a black background.

For the images of India, fires were present on 24 March and 25 March. Two images are present in the archive for each night that were acquired approximately one hour apart, one from DMSP satellite F-6 and one from F-8. Figure 63.1 shows a nighttime image of India from 3 February 1987, a night with many city lights and no fires. Figure 63.2 shows a nighttime image of India from 25 March 1987 showing large areas of biomass burning in the eastern portion of India.

In peninsular Southeast Asia, fires were observed 20 January, 5 February, 27 February, 10 March, and 24 March, primarily in Thailand, Myanmar, Laos, Cambodia, and Vietnam. Figure 63.3 shows a nighttime image of Southeast Asia without fires, acquired on 28 April 1987. Figure 63.4 shows a nighttime image from 24 February with fires in Thailand, Myanmar, and Cambodia. No fires were observed in the Philippines, Malaysia, Indonesia, or Papua, New Guinea.

Photographic prints were made of the images showing fires and also of the select images without fires that exhibited large numbers of city lights. The prints of the images showing fires were digitally scanned. The scanned images with fires were georeferenced by use of image to map warping, manually matching city lights to the corresponding populated place lines from the Defense Mapping Agency (DMA) Digital Chart of the World (DCW). The DCW populated place lines are shown in figures 63.5 and 63.6. After being georeferenced, polygons were drawn around areas that were visually interpreted as fires. The city lights and other features outside of the fire polygons were then set to zeroes, leaving only fires in the georeferenced images. The fire images were added together to produce images depicting the cumulative extent of biomass burning in India and Southeast Asia (Figures 63.7 and 63.8).

Discussion

Evidence from DMSP-OLS analog images indicates that there were two major areas of biomass burning in India and Southeast Asia during 1987. During March large sections of east-central India were burned (figure 63.7). During January, February, and March extensive areas were burned in Thailand, Myanmar, Laos, Cambodia, and Vietnam (figure 63.8).

Despite our success in identifying regions with fires in India and Southeast Asia during 1987, there are several cautionary points that must be raised. First, we have not calibrated our DMSP-OLS fire observations to burn area. That is to say, the cumulative extent of the fire observations, shown in figures 63.7 and 63.8 should not be taken directly as burn area. Because it is possible to detect burns that are subpixel in size, the actual area burned during 1987 is likely to have been smaller than the regions shown in figures 63.7 and 63.8. Second, we suspect that there were fires in many other parts of India and Southeast Asia during 1987 that were not detected in our survey. For instance, we have not observed fires in the Philippines, Malaysia, Indonesia, or Papua, New Guinea. Fires could have gone undetected in our survey due to gaps in the DMSP-OLS analog archive. The procedures we followed are most amenable to the detection of large areas that were burning on the same night. Therefore, small fires tend to be missed. Finally, fires that did not continue burning into the night would also be missed.

In order to complete the fire inventory required for the GEIA project, we recommend augmenting the DMSP-OLS fire observation with active fire and burn scar surveys with digital NOAA-Advanced Very High Resolution Radiometer (AVHRR) data.

Acknowledgment

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